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(54) HOT ROLLED WIRE ROD AND STEEL BAR FOR MACHINE STRUCTURE AND MANUFACTURE OF THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a wire rod and steel bar for steel structure having cold workability equal to that of the wire rod, steel bar being subjected to conventional spheroidizing annealing for a long time, by controlling steel structure, through time for spherodizing annealing is shortened.
SOLUTION: This is a steel consisting of, by weigh %, 0.1-0.5% C, 0.01-0.5% Si, 0.3-1.5% Mn, and the balance Fe with inevitable impurities, and contains reinforcing elements as necessary. Its microstructure consists of ferrite and pearlite, a grain size number of ferrite specified by JIS G 0552 is at least 11, and contains, by area ratio, 3-15% granular carbide having a diameter corresponding to a circle of 2 μm or below and aspect ratio of 3 or above and satisfy hardness required by a formula: 165Ceq+73.5≤Hv≤195Ceq+73.5 (where, Ceq=C %+1/7SI%+1/5Mn%+1/9Cr%).

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CLAIMS

[Claim(s)]
[Claim 1] At weight %, it is C. : 0.1 - 0.5%, Si:0.01-0.5%, It is the steel which consists of the remainder Fe and an unescapable impurity Mn:0.3-1.5%. A microstructure consists of a ferrite and a pearlite and it is JIS. G The ferritic grain size number specified by 0552 is 11 or more. A circle equivalent diameter by 2 micrometers or less And contain three or less granular carbide by the aspect ratio, and 3 - 15% is contained at the rate of area. The machine structural steel worker hot rolling wire rod and steel bar characterized by hardness (Hv) filling following type 165Ceq+73.5 <=Hv<=195Ceq+73.5 (however, Ceq=C%+1/7Si%+1/5Mn%+1/9Cr%).
[Claim 2] It is weight % and they are Cr:0.2-2.0%, Mo:0.1-1.0%, nickel:0.3-1.5%, less than [Cu:1.0%], and B further. : The machine structural steel worker hot rolling wire rod and steel bar according to claim 1 characterized by containing two of one sort or 0.005% or less of sorts or more.
[Claim 3] It is weight % and they are Ti:0.005-0.04%, Nb:0.005-0.1%, and V further. : The machine structural steel worker hot rolling wire rod and steel bar according to claim 1 or 2 characterized by containing two of one sort or 0.03 - 0.3% of sorts or more.
[Claim 4] Hot rough rolling of the steel which has the steel component of a publication is carried out to either of the claims 1-3 in a less than 850-1000-degree C temperature requirement. Controlled cooling after finishing rolling and of within the limits of 700-400 degrees C is carried out in the temperature requirement of 3+150 degree C of Ar3 to Ar(s) with a cooling rate with a cooling rate of 5 degrees C [/second] or more. It holds 15 minutes or more immediately for less than 1 hour in the furnace ambient temperature range of 500-700 degrees C, and is JIS. G The ferritic grain size number specified by 0552 is 11 or more. A circle equivalent diameter by 2 micrometers or less And contain three or less granular carbide by the aspect ratio, and 3 - 15% is contained at the rate of area. The manufacture approach of of the machine structural steel worker hot rolling wire rod and steel bar characterized by making it hardness (Hv) fill following type 165Ceq+73.5 <=Hv<=195Ceq+73.5 (however, Ceq=C%+1/7Si%+1/5Mn%+1/9Cr%).

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] About a machine structural steel worker hot-rolling wire rod, a steel bar, and its manufacture approach, in more detail, this inventions are the machine structural steel worker wire rod and steel bar for manufacturing the components for automobiles, the components for construction equipments, etc., are giving short-time spheroidizing, are drawn out and relate to the machine structural steel worker wire rod and steel bar which enabled cooling processing of cutting, cold forging, etc., and its manufacture approach.
[0002]
[Description of the Prior Art] Conventionally, after machine structural steel worker components, for example, a bolt, such as components for automobiles and components for construction equipments, a stabilizer, etc. give softening to machine structural carbon steel, or the hot-rolling wire rod and steel bar of alloy steel and secure cold-working nature, they are fabricated by cold working, such as cold forging, drawing, and cutting, give hardening annealing, and let them be shaping components.
[0003] the case where this softening process manufactures a bolt from a hot-rolling wire rod -- a stud bolt with few amounts of cold working -- low temperature annealing -- a hexagon-headed bolt -- usually -- annealing -- moreover, with the collar-head bolt with many amounts of cold working, spheroidizing was given to the hot-rolling wire rod and cold-working nature is secured.
[0004] However, such a softening process, especially a spheroidizing process take the long duration of about 20 hours, and it has become a trouble for a productivity drive at them. Furthermore, the cost of annealing processing occupies big weight increasingly in manufacturing costs, such as a machine part, for an energy jump in recent years.
[0005] For this reason, the technique about shortening the spheroidizing time amount before cold working is variously proposed from the improvement in productivity, and a viewpoint of energy saving.
[0006] For example, in JP,56-41325,A, after quenching the wire rod after hot rolling, the manufacture approach of an elasticity-ized wire rod of having elasticity-ized the wire rod to effective level, and having omitted elasticity-ized annealing in secondary elaboration is indicated by performing controlled cooling of specific conditions and considering as a uniform fine pearlite organization. However, there is no technical indication to obtaining the elasticity-ized wire rod which is equal to cold working with many equivalent amounts of processings with having given spheroidizing.
[0007] Moreover, in JP,60-21327,A, it cools quenching the wire rod rolled out with the finishing mill between [of the 1st step] heat, and the finishing mill of the 2nd step giving a plastic strain succeedingly, and giving a plastic strain, and making balling-up at degree process easy is indicated. However, this approach does not make spheroidizing quick by making spheroidizing quick and controlling a steel organization by the plastic strain.
[0008]
[Problem(s) to be Solved by the Invention] Then, even if this invention shortens spheroidizing time amount by controlling a steel organization in view of the above-mentioned present condition, it makes it a technical problem to offer the machine structural steel worker wire rod and steel bar which has

cold-working nature equivalent to the wire rod and steel bar which gave spheroidizing of the conventional long duration, and its manufacture approach.
[0009]
[Means for Solving the Problem] Paying attention to the organization of the wire rod and steel bar obtained by spheroidizing, this invention person attained balling-up and elasticity-ization by short-time spheroidizing, and studied securing cold-working nature by obtaining an organization equivalent to the conventional spheroidizing.
[0010] After this invention person performs low-temperature hot rolling to the slab of a specific steel presentation, the steel-wire material and steel bar which controlled and acquired cooling conditions That the new steel organization which is a detailed ferrite pearlite organization and a part of cementite in a pearlite granulated is obtained as shown in drawing 1 , and its sake, The knowledge of the conventional thing which can be shortened to 2 by about 1/was carried out for the elevated-temperature retention time amount of spheroidizing time amount, and this invention was completed.
[0011] The summary of this invention is as follows.
[0012] (1) At weight %, it is C. : 0.1 - 0.5%, Si:0.01-0.5%, It is the steel which consists of the remainder Fe and an unescapable impurity Mn:0.3-1.5%. A microstructure consists of a ferrite and a pearlite and it is JIS. G The ferritic grain size number specified by 0552 is 11 or more. A circle equivalent diameter by 2 micrometers or less And contain three or less granular carbide by the aspect ratio, and 3 - 15% is contained at the rate of area. The machine structural steel worker hot rolling wire rod and steel bar characterized by hardness (Hv) filling following type 165Ceq+73.5 <=Hv<=195Ceq+73.5 (however, Ceq=C%+1/7Si%+1/5Mn%+1/9Cr%).
[0013] (2) It is weight % and they are Cr:0.2-2.0%, Mo:0.1-1.0%, nickel:0.3-1.5%, less than [Cu:1.0%], and B further. : The machine structural steel worker hot rolling wire rod and steel bar of the above-mentioned (1) publication characterized by containing two of one sort or 0.005% or less of sorts or more.
[0014] (3) It is weight % and they are Ti:0.005-0.04%, Nb:0.005-0.1%, and V further. : A machine structural steel worker hot rolling wire rod and steel bar the above (1) characterized by containing two of one sort or 0.03 - 0.3% of sorts or more, or given in (2).
[0015] (4) The above (1) the steel which has the steel component of a publication in either of - (3) Hot rough rolling is carried out in a less than 850-1000-degree C temperature requirement. In the temperature requirement of 3+150 degree C of Ar3 to Ar(s) After finish rolling, Controlled cooling of within the limits of 700-400 degrees C is carried out with a cooling rate with a cooling rate of 5 degrees C [/second] or more. It holds 15 minutes or more immediately for less than 1 hour in the furnace ambient temperature range of 500-700 degrees C, and is JIS. G The ferritic grain size number specified by 0552 is 11 or more. A circle equivalent diameter by 2 micrometers or less And contain three or less granular carbide by the aspect ratio, and 3 - 15% is contained at the rate of area. The manufacture approach of of the machine structural steel worker hot rolling wire rod and steel bar characterized by making it hardness (Hv) fill following type 165Ceq+73.5 <=Hv<=195Ceq+73.5 (however, Ceq=C%+1/7Si%+1/5Mn%+1/9Cr%).
[0016]
[Embodiment of the Invention] Hereafter, this invention is explained to a detail.
[0017] The steel organization consists of a ferrite and a lamellar pearlite, and the conventional hot-rolling wire rod and steel bar have high reinforcement, is as [hot-rolling] and is difficult to carry out cold working with many amounts of processings. Therefore, before cold working, spheroidizing is given and elasticity-ized processing is carried out, and after cold working, hardening annealing is heat-treated and it is considering as the fabrication components of predetermined reinforcement.
[0018] This invention enables compaction of spheroidizing time amount performed before cold working by controlling the organization of a hot-rolling wire rod and a steel bar.
[0019] In order for this invention person to secure elasticity-ization by short-time spheroidizing paying attention to the steel organization of the wire rod and steel bar in front of spheroidizing In order it is required in a ferrite pearlite organization to attain elasticity-ization and to promote balling-up Making it the

most detailed possible ferrite pearlite and making homogeneity distribute carbon carried out the knowledge of the desirable thing, and it found out the new steel organization of a hot-rolling wire rod and a steel bar which can get a steel organization equivalent to the spheroidizing material conventional by spheroidizing in the elevated-temperature retention time amount of the conventional abbreviation 1/2.

[0020] First, the steel organization of this invention is explained.

[0021] Drawing 1 is a microphotography (x1000) in which the steel organization of the wire rod and steel bar of a hot-rolling [of this invention] as is shown. As shown in drawing 1 , the steel organization is the new organization which consists of the fine crystal organization of a ferrite (alpha) and a pearlite, and contains the granular carbide (cementite) which spheroidized.

[0022] Drawing 2 is a microphotography (x1000) in which the steel organization of the wire rod of the conventional hot-rolling as is shown. The organization of the wire rod of the conventional hot-rolling as consists of the big grain structure of a ferrite and a lamellar pearlite.

[0023] Drawing 3 is the microphotography (x1000) after carrying out spheroidizing of the material of drawing 1 , and drawing 4 is the microphotography (x1000) after carrying out spheroidizing of the material of drawing 2 .

[0024] In this invention, a ferrite grain size is small so that clearly [contrast / drawing 1 and drawing 2], and it is JIS. G The ferritic grain size number specified by 0552 is 11 or more.

[0025] Thus, since the carbonaceous diffusion length becomes short by making a grain size number number or more into 11, by spheroidizing annealing, dissolution of carbide can quicken, and as shown in drawing 3 , the granulation object with which the cementite spheroidized for a short time can be obtained. And the rate of granulation is improving about 5% or more conventionally. This organization brings about the cold-working nature which the granulation object was distributing to homogeneity and was excellent in it as compared with the organization of the conventional spheroidizing material which shows drawing 4 .

[0026] Moreover, in this invention, since granular carbide (cementite) is included during the organization as shown in drawing 1 , at the time of spheroidizing, this granular carbide serves as a nucleus and can form a granulation cementite easily. That is, in order to shorten the time amount of spheroidizing, a circle equivalent diameter is 2 micrometers or less, and it is required to include three or less granular carbide 3 to 15% at the rate of area by the aspect ratio.

[0027] Furthermore, hardness (Hv) fills following type $165Ceq+73.5 <= Hv <= 195Ceq+73.5$ (however, $Ceq=C\%+1/7Si\%+1/5Mn\%+1/9Cr\%$) with this invention by considering as the steel component and steel organization of this invention. If the above-mentioned hardness is not filled, compaction of spheroidizing time amount will become difficult.

[0028] Since balling-up is promoted at the time of spheroidizing according to this invention as stated above, balling-up can be attained for elevated-temperature retention time amount by the annealing time amount of the conventional abbreviation 1/2. In addition, they are the time amount for carrying out the temperature up of the material to predetermined homogeneity temperature, or the time amount for carrying out a temperature reduction except elevated-temperature retention time amount.

[0029] Next, the reason which limited the component of the object steel in this invention is explained.

[0030] Although C was an element required since the reinforcement as machine structural steel worker components is increased, since it caused degradation of the toughness of a final product rather when the reinforcement of a final product was insufficient for it at less than 0.1% and it exceeded 0.5%, it made C content 0.1 - 0.5%.

[0031] Although Si was added for the purpose of making the reinforcement of the final product by solid-solution hardening increase as a deoxidation element, less than 0.01% of these hardening was insufficient, and since these hardening was saturated and degradation of toughness was rather caused when it exceeded 0.5%, on the other hand, Si content was made into 0.01 - 0.5%. In addition, aluminum deoxidation is also adopted besides deoxidation according [deoxidation of steel] to Si. Application of aluminum deoxidation powerful for making especially an oxygen content low is desirable. In such a case, although 0.2% or less of aluminum may remain in steel, in this invention, the residual of this aluminum is permissible.

[0032] Although Mn was an element effective in making the reinforcement of a final product increase through improvement in hardenability, since this effectiveness was saturated with less than 0.3% when this effectiveness is insufficient and exceeded 1.5% on the other hand, and degradation of toughness was caused rather, Mn content was made into 0.3 - 1.5%.
[0033] Moreover, since S is a component contained unescapable in steel, exists as MnS in steel and contributes to the improvement in machinability, and detailed-ization of an organization, in this invention, it is permissible S:0.1% or less. However, for cold-forming processing, since it is a harmful element, when it does not need machinability, controlling to 0.035% or less is desirable [S].
[0034] Furthermore, although it is the component which also contains P unescapable in steel, as for P, it is desirable to control grain boundary segregation and a main segregation to 0.035% or less in steel, since it becomes the cause of a lifting and toughness degradation.
[0035] Although the above is the fundamental component of the target steel [this invention], one sort of Cr, Mo, nickel, Cu, and B or two sorts or more can be made to contain as a strengthening element further in this invention. These elements are added in order to make the reinforcement of a final product increase by the increment in hardenability etc. However, it is as [hot rolling], abundant addition of these elements produces bainite and martensitic structure, it causes the increment in hardness, and since it is not desirable in respect of economical efficiency, it is Cr:0.2-2.0%, Mo:0.1-1.0%, nickel:0.3-1.5%, less than [Cu:1.0%], and B about the content. : It could be 0.005% or less.
[0036] Furthermore, it is the purpose of grain refining and one sort of Ti, Nb, and V or two sorts or more can be made to contain in this invention. V content less than 0.005% less than 0.005% however, at less than 0.03% [Ti content] [Nb content] Since the effectiveness is insufficient, as for super-****** and its effectiveness, 0.1% ** and V content are saturated [Ti content] by 0.04% ** and Nb content 0.3% on the other hand and toughness is degraded rather About these contents, they are Ti:0.005-0.04%, Nb:0.005-0.1%, and V. : It could be 0.03 - 0.3%.
[0037] Next, the manufacture approach of of the machine structural steel worker wire rod and steel bar of this invention is described.
[0038] Drawing 5 is drawing of the CCT diagram explaining the cooling conditions in the production process of this invention.
[0039] Let this inventions be a wire rod and a steel bar with a new steel organization by performing finish rolling at low temperature to steel according to claim 1 to 3, performing grain refining of an austenite grain, controlling a cooling rate and producing a ferrite and a pearlite transformation so that it may be shown subsequently to drawing 5 . The obtained wire rod and steel bar can shorten spheroidizing time amount, and an annealed material can be used as good machine structural steel worker wire rod and steel bar of cold-working nature.
[0040] In this invention, first, hot rough rolling of the slab is carried out in a less than 850-1000-degree C temperature requirement, and finish rolling is performed in the temperature requirement of Ar3-3+200 degree C of Ar(s) of right above [Ar3]. Subsequently, it continues at the above-mentioned low-temperature rolling, controlled cooling of for at least 700-400 degrees C is carried out with the cooling rate of 5 degrees C/second or more, and the retention is immediately carried out to furnace 500-700-degree C ambient temperature within the limits 15 minutes or more for less than 1 hour.
[0041] Hot rough rolling was made into less than 850-1000 degrees C for austenite crystal grain making it big and rough, when less than 850 degrees C of grain refining of an austenite grain are insufficient and it became 1000 degrees C or more. Since an austenite grain is made detailed and a grain boundary serves as a ferrite nucleation site by performing finish rolling right above [Ar3], a ferrite transformation is promoted, and a ferrite molar fraction also increases, and it is JIS. G It can consider as the ferritic grain size number 11 specified by 0552. Although it was desirable to have performed finish rolling right above [Ar3], since the real operation top was difficult to maintain to the temperature of Ar3 right above, it set the permissible upper limit to 3+200 degree C of Ar(s) by this invention. in addition -- less than three-Ar finishing temperature -- an austenite and rolling in the two-phase region of a ferrite -- becoming -- after rolling -- homogeneity -- a detailed ferrite pearlite organization gets -- not having -- a part -- reed -- it becomes a

KYURA ferrite bainite texture and is not desirable.
[0042] According to low-temperature rolling of this invention, as shown in the CCT diagram of drawing 5 , a ferrite transformation arises immediately, ferrite transformation initiation shifts to a short-time side like an alternate long and short dash line, and a ferrite molar fraction comes to increase. Since a pearlite transformation is also shifted to a short-time side so that it may be dragged, the temperature of transformation serves as elevated-temperature-ization and diffusion of C becomes quick, while granulation of a cementite arises, it carries out vast [of the pearlite lamellar spacing].
[0043] If cooling initiation temperature is not cooled from at least 700 degrees C, detailed-ization of a ferrite pearlite is not fully attained. On the other hand, 400degrees C or more of detailed-ization of a ferrite pearlite cannot attain it, if annealing termination temperature is not preferably made into 450 degrees C or more. Therefore, it considered as the temperature within the limits of 700-400 degrees C.
[0044] Moreover, if a cooling rate becomes a second in less than 5 degrees C /, it not only becoming impossible to attain granulation of a cementite, double-width-izing of pearlite lamellar spacing, and the increment in a ferrite molar fraction but it cannot attain detailed-ization of a ferrite pearlite.
[0045] Therefore, by this invention, within the limits of 700-400 degrees C was cooled with the cooling rate of 5 degrees C/second or more. In addition, what is necessary is just to cool by warm water or the air blast as a cooling means. Elasticity-ization is attained with granulation of a cementite after controlled cooling by holding 15 minutes or more immediately for less than 1 hour in the furnace ambient temperature range of 500-700 degrees C.
[0046] Consequently, a circle equivalent diameter can make three or less granular carbide (cementite) contain 3 to 15% at the rate of area by the aspect ratio by 2 micrometers or less.
[0047]
[Example] Below, the example of this invention shows still more concretely.
[0048] The chemical entity of a test specimen is shown in Table 1. Each of these was manufactured by continuous casting after the converter ingot. It rolled out to 11mm meridianus material on the rolling conditions shown in Table 2 after slabbing at the piece of 162mm ****. Rolling No.1 of this invention method is warm water cooling after finish rolling, or air blast cooling (it carries out with steel materials with high hardenability.) at 750 degrees C which hot rough rolling is carried out at 900 degrees C, and is the temperature requirement of 3+150 degree C of Ar3 to Ar(s). The items are shown in Table 2. It carried out, wire rod temperature ended accelerated cooling below 400 degrees C or more 650 degrees C, and it held to the lehr of 600-degree C ambient temperature immediately after that for 30 minutes. Then, short-time spheroidizing was performed. To the elevated-temperature retention temperature of 740 degrees C and spheroidizing of in-furnace time 17 hours which are mentioned later, this processing reduced the elevated-temperature holding time by half, and made in-furnace time 13.5 hours. About rolling No.II of the example of a comparison, hot rough rolling was carried out and controlled cooling was performed after 900-degree C finish rolling 1050 degrees C by covering annealing covering over coil conveyance Rhine. Then, about rolling No.II of the example of a comparison, the usual spheroidizing of elevated-temperature retention temperature [of 740 degrees C] and in-furnace time 17 hours was performed.
[0049] As an index which promotes balling-up in material as [rolling], this invention and the example of a comparison are contrasted and tensile strength, a microstructure, a ferritic grain size number, and the rate of area of granulation carbide are shown in Table 3. Moreover, evaluation of tensile strength, the rate of balling-up, and a diaphragm was performed as an index of a balling-up degree. This invention and the example of a comparison are contrasted and a result is shown in Table 3.
[0050] Although most of detailed-izing and granulation carbide of a ferrite grain size is not admitted by as [rolling] in rolling No.II of the example of a comparison, though detailed-izing and granulation carbide of a ferrite grain size of No. 11 exist so much, therefore the elevated-temperature holding time is shortened to conventional one half, the balling-up organization and elasticity-ized level beyond a conventional method are attained by this invention method from now on, so that clearly.
[0051]
[Table 1]

(wt%)

鋼No	C	Si	Mn	P	S	Cr	Mo	Al	Ni	Cu	B	Ti	Nb	V
A	0.44	0.23	0.78	0.014	0.025	0.05	−	0.023	−	−	−	−	−	−
B	0.40	0.24	0.68	0.011	0.010	−	−	0.025	−	−	−	−	−	−
C	0.35	0.25	0.70	0.013	0.008	−	−	0.025	−	−	−	−	−	−
D	0.25	0.23	0.71	0.012	0.010	−	−	0.024	−	−	−	−	−	−
E	0.40	0.25	0.77	0.020	0.020	1.02	−	0.032	−	−	−	−	−	−
F	0.35	0.19	0.80	0.015	0.022	1.00	0.18	0.033	−	−	−	−	−	−
G	0.15	0.20	0.55	0.013	0.022	0.55	0.17	0.029	0.55	−	−	−	−	−
H	0.25	0.26	0.35	0.010	0.009	−	−	0.030	−	−	0.0018	0.02	−	−
I	0.45	0.04	0.35	0.014	0.006	−	−	0.020	−	−	0.0020	0.02	−	−
J	0.25	0.20	0.35	0.008	0.008	−	−	0.035	−	0.20	0 0016	0.04	−	−
K	0.24	0.23	0.34	0.010	0.015	−	−	0.030	−	−	0.0020	0.02	0.05	−
L	0.25	0.25	0.37	0.011	0.014	−	−	0.025	−	−	0.0025	0.02	−	0.10

[0052]
[Table 2]

区分	圧延No.	圧延材径 (mm)	粗圧延温度 (℃)	仕上げ圧延温度 (℃)	圧延後の冷却 (700～400℃)	徐冷処理
本発明法	I	11	900	750	温水、衝風	600℃雰囲気炉×30分
比較例	II	11	1050	900	徐冷カバー	無し

[0053]
[Table 3]

区分	記号	鋼No.	圧延No.	圧延まま材				球状化焼鈍材		
				ミクロ組織	フェライト粒度番号	引張強度 (MPa)	粒状炭化物分率(%)	引張強度 (MPa)	球状化率(%)	絞り (%)
本発明	1	A	I	F+P+S	12.5	611	9	495	95	67
比較例	2	〃	II	F+P	8.5	704	−	497	90	65
本発明	3	B	I	F+P+S	12.3	585	7	470	95	65
比較例	4	〃	II	F+P	8.5	653	−	474	90	64
本発明	5	C	I	F+P+S	12.0	540	7	452	95	70
比較例	6	〃	II	F+P	8.3	591	−	457	90	65
本発明	7	D	I-1	F+P+S	12.1	474	6	424	95	68
比較例	8	〃	II	F+P	9.1	511	−	428	90	66
本発明	9	E	I-2	F+P+S	12.3	717	8	545	95	65
比較例	10	〃	II	F+P	9.0	748	−	547	90	62
本発明	11	F	I-2	F+P+S	12.1	652	5	555	95	69
比較例	12	〃	II	F+P	8.9	734	−	564	90	63
本発明	13	G	I-2	F+P+S	12.4	596	7	559	95	67
比較例	14	〃	II	F+P	9.1	748	−	568	90	66
本発明	15	H	I-2	F+P+S	11.9	560	6	454	95	67
比較例	16	〃	II	F+P	8.8	646	−	459	90	63
本発明	17	I	I-2	F+P+S	11.5	484	9	453	95	69
比較例	18	〃	II	F+P	9.0	571	−	459	90	64
本発明	19	J	I-2	F+P+S	11.7	562	8	465	95	70
比較例	20	〃	II	F+P	9.1	662	−	469	95	65
本発明	21	K	I-2	F+P+S	12.8	560	8	471	90	65
比較例	22	〃	II	F+P	9.1	662	−	477	80	63
本発明	23	L	I-2	F+P+S	12.7	515	8	523	90	63

[0054]
[Effect of the Invention] The machine structural steel worker hot-rolling wire rod and steel bar of this invention are the wire rod and steel bar with which spheroidizing before cold working could be performed by the elevated-temperature retention time amount of the conventional abbreviation 1/2, and also whenever [elasticity] gave the conventional spheroidizing, and a thing more than equivalent. Therefore, in this invention, since the time amount of spheroidizing is shortened, the effectiveness that improvement and energy saving of productivity can be attained is done so.

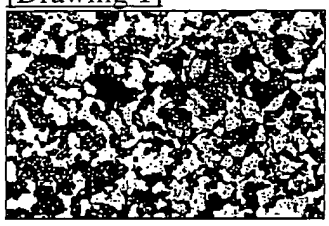
[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



(× 1000)

[Drawing 2]

(× 1000)

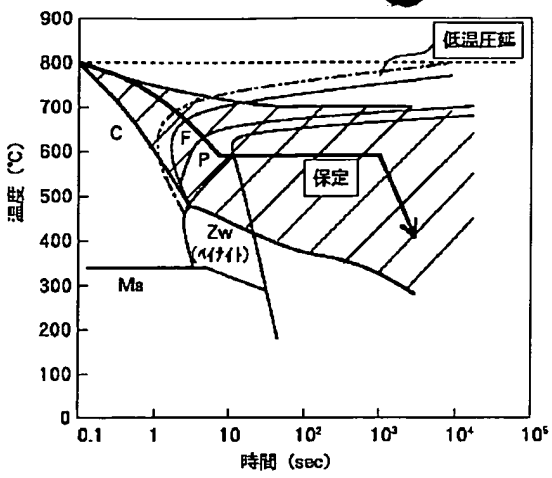
[Drawing 3]

(× 1000)

[Drawing 4]

(× 1000)

[Drawing 5]



[Translation done.]